Process Evaluation Section

Recovery and Recycling of Glass-Manufacturing Waste and Fiberglass Scrap

Problem/Opportunity

The glass industry generates more than 60,000 tons of glass-manufacturing waste annually from the glass-fiber forming process alone. Attempts by industry to recycle this waste stream have failed because it has resulted in an unacceptably high rate of filament breakage in the subsequent glass-manufacturing processes. This breakage rate is due to the presence of impurities in the glass waste material. An additional 200,000 tons of fiberglass waste, shown in figure 1, is annually generated during the manufacturing of fiberglass products. The ability to use recycled glass fibers lowers energy costs by an average of $3-$8 per ton of glass fibers, when compared to using virgin raw materials. If these waste-glass streams are recycled, the glass industry will annually save over $2 million in energy costs and over $5 million in disposal costs. Associated with the energy savings is also a 70,000 ton/yr reduction in CO_2 emissions and a significant reduction in NO_X emissions.

Figure 1. Glass-Fiber-Forming Manufacturing Waste

Approach

The objective of this project is to develop a technology that will enable the Glass Fiber Industry to recycle its glass-fiber-forming and fiberglass-manufacturing scrap into new glass products without either adversely impacting its operations, or the quality of its products due to the increasing glass-filament breakage rate.

Our technical approach consisted of 3 stages:

1. Identify the contaminants present in the waste-glass material that may cause filament breakage.
2. Develop a technology to remove the contaminants.
3. Conduct environmental impact and economic competitiveness analyses of the process. Test the process in an industrial plant.

Results

This project was conducted as a Collaborative Research and Development Agreement (CRADA) with two industrial partners, Vetrotex America and CertainTeed. We also had extensive discussions with scientists and engineers from other industrial plants.

We conducted scanning electron microscope (SEM), Inductive coupling plasma (ICP), and mass spectroscopy analyses of virgin glass (see figure 2.), manufacturing-glass-fibers waste (see figure 3), fiberglass waste, and the glassy residue material that remained at the bottom of an industrial furnace used to recycle manufacturing-glass waste. We concluded that the major contaminants present in the glass-manufacturing waste material are:

a) Carbonaceous material from the polymeric coating layer. The waste fibers contain between 0.1 to 0.7 wt % polymeric coatings on the fiber surfaces (~0.25% average).

b) Tiny noble metal particles (a few micrometers in size) from the "bushings". The concentration of these is on the order of parts per trillion (PPT).

c) The residue from the industrial furnace showed elevated levels of Zr, Sr, Cr, Cu, Mg, Zn, Fe, Ba, V, and Mn. We are not sure at this time why this is so. However, it is likely that some of these contaminants were introduced during the preparation, shredding and conveying of the waste fibers for recycling.

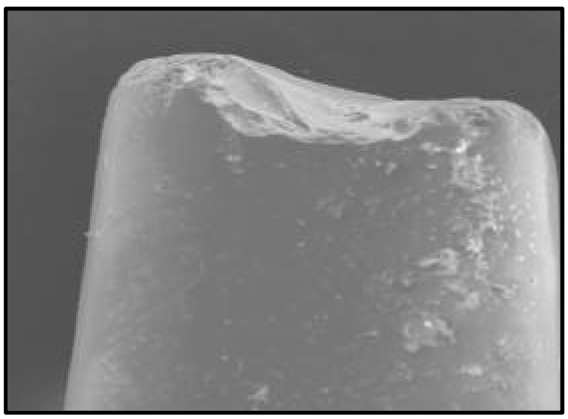

Figure 2. SEM Picture of Virgin Glass.

In order to develop a process for the removal of the polymeric binder material (which is the major contaminant), off of the glass-fiber waste, we tested two methods: thermal treatment and chemical degradation.

Both methods were capable of removing the polymeric binder material off of the glass-manufacturing waste and off of the fiberglass scrap. The experimental results proved that the thermal-treatment process can produce cleaned glass fibers from the glass-fiber manufacturing waste, reducing the total-carbon content from several thousand PPM to less than 100 PPM. This is the total-carbon content level that is observed in the virgin "uncoated" glass fibers. The thermal-treatment process was also capable of removing over 99.5% of the polymeric binder material off of the fiberglass. This process involves shredding the glass-fiber waste, as well as the fiberglass scrap, to a manageable size and then processing it at temperatures below its melting point to remove the polymer-coating binder layer.

The chemical method however, was not as effective. It required different chemicals for different polymers, and it failed to completely clean the fiberglass scrap. Additionally, the chemical method was more costly than the thermal-treatment process and it produced a liquid waste.

Once the technical feasibility of these processes was proven, environmental assessment and economic analysis of both processes were then conducted to evaluate their cost effectiveness. Economic analysis of the thermal-treatment process shows a potential payback of less than 2 years. The thermal-treatment process, therefore, was the preferred method.

Large scale tests of the thermal treatment process utilizing fiberglass waste at an industrial plant have just begun.

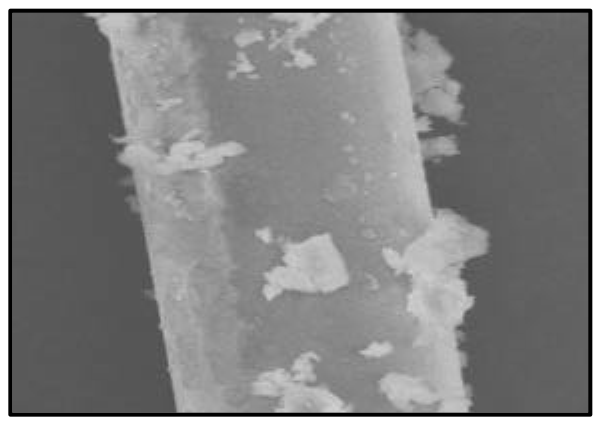

Figure 3. SEM Picture Un-Cured, (Polymeric-Coated) Glass-Fiber-Waste.

Future Plans

Our future plans for the thermal-treatment technology include:

(1) Demonstration of the process using glass-fiber-manufacturing waste and fiberglass scrap.

(2) Commercialization of the technology.